Global Coupled Data Assimilation System Development

Richard M. Hodur
Naval Research Laboratory
Monterey CA 93943-5502
phone: (831) 656-4788 fax: (831) 656-4769 e-mail: hodur@nrlmry.navy.mil
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LONG-TERM GOAL

The long-term goal is to develop a fully coupled, global, atmosphere-ocean-ice prediction system that can be used for 0-10 forecasts. This goal is to be accomplished by coupling a full-physics, global ocean model to a global atmospheric forecast model; developing, testing, and evaluating software for the necessary supporting infrastructure; and by leveraging related programs to develop an ocean data assimilation capability. This prediction system will be the cornerstone of a vertically integrated program such that it will be used for basic and applied research to study forecast problems in which coupling may be important and it will also be transitioned to 6.4 for evaluation as an operational analysis/forecast system. In operations, it is expected that this system will provide improved capabilities to describe the atmosphere and the ocean at the analysis and forecast times (to 10 days ahead) and to provide high resolution initial and boundary data for the atmosphere, ocean, and ice to a mesoscale coupled data assimilation system.

OBJECTIVES

The objective is to develop the components of a global, scalable, coupled data assimilation system comprised of atmosphere, ocean, and ice modeling components, and to perform validation tests of these components separately, and in an integrated fashion. The atmosphere and ocean components will each contain programs to perform data quality control, data analysis, initialization, and numerical forecasts.

APPROACH

Our approach is to build the system using a combination of existing and newly-developed components. For the atmosphere, the Navy Operational Global Atmospheric Predictions System (NOGAPS) has been shown to be among the leading atmospheric data assimilation systems in the world. NOGAPS will be used for the atmospheric component of the coupled system. For the ocean component, we will leverage work on-going at other institutions [e.g., Naval Postgraduate School (NPS), NRL Stennis Space Center (NRL SSC)]. Some of these projects include the development of a 3-dimensional ocean multivariate optimum interpolation analysis (3D MVOI, NRL MRY), the global version of the Navy Coastal Ocean Model (Global NCOM, NRL SSC), the testing of the Parallel Ocean Prediction (POP) ocean model at NPS, and the development of the next-generation Polar Ice Prediction System (PIPS 3.0) in a joint project headed by NRL SSC. The coupled system will be designed for scalable computer architecture. Initial development will involve the testing and/or development of key components of the system, understanding of the systematic errors in NOGAPS, and the development of atmospheric datasets that can be used for the validation of the ocean model. This development will

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transition to a related 6.4 project that will focus on the design and implementation of this system for operational use.

WORK COMPLETED

1. The atmospheric forecast model within NOGAPS has been redesigned for optimum use on distributed memory computers.

2. Produced atmospheric forcing fields appropriate for early one-way atmosphere-ocean coupling tests.

RESULTS

The scalable version of NOGAPS has been tested against the current operational version. These tests demonstrate that the scalable version reproduces the results of the operational version. The design of this new version of NOGAPS is critical for the eventual use of the coupled system on the newer computer architectures.

The development of the NOGAPS forcing fields allows us to perform one-way coupled experiments with the ocean model. Although these forcing fields are derived from the operational analyses, they provide a more consistent set of fields since only one version of the forecast model is used to generate all the forecasts. In operations, the forecast model undergoes incremental upgrades, which has the potential for introducing time-varying systematic errors into the fields. A compete reanalysis by NOGAPS was found to be prohibitively expensive for this project.

IMPACT/APPLICATIONS

Our development of a global, fully-coupled atmosphere-ocean-ice prediction system will have a dual application. The first will be the transition of this system to 6.4, and eventually, to operations in support of Navy missions. The second application will be to our basic and applied research program. A tool such as a coupled atmosphere-ocean data assimilation system will allow us to study a wide range of scientific topics that could not be done without the development of such a system. This research will be used for testing hypotheses and theories, that if successful, would be transitioned to the operational system.

TRANSITIONS

The results and data that we generate as part of this program will be used by scientists at the Naval Postgraduate School. Currently, NPS has an active research program involving POP, and NRL MRY is collaborating on this work in the exchange of data and science issues.

RELATED PROJECTS

This project is complemented by other NRL MRY 6.1 projects on atmospheric predictability (BE033-03-4) and data assimilation (BE-33-03-45); 6.2 projects on data assimilation (BE-35-2-19) and global

model development (BE 35-2-18); and 6.4 SPAWAR projects on data assimilation (X-2342-0) and Large-Scale Atmospheric Models (X-2342-0).